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MILITARY SKILLS IN A CHANGING TECHNOLOGY

by

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MILITARY SKILLS IN A CHANGING TECHNOLOGY

Paul M. Fitts
The University of Michigan

This paper attempts to identify some of the significant implications of recent technological changes for military skills. Two of the major technological changes that will be considered are (a) the great increase in firepower resulting from the development of atomic weapons, and (b) the great increase in complexity of military equipment resulting from extensive use of electronic devices such as radars and computers.

It is important for the military psychologist to identify the changes in military skills which will be brought about by technological advances. First, selection and training procedures must be kept up-to-date, and research on selection and training often needs to anticipate the actual technological change. Second, it often is possible to influence the direction and rate of technological change, for the purpose of achieving more effective overall man-machine systems and of minimizing undesirable consequences of technological change on men in service.

Shifts in Activities and Duties

The effects of technological change can be considered at a gross level, in terms of shifts in the total numbers of men assigned to broad classes of duties. Such effects will be considered first, before a more detailed analysis of the nature of changes in certain specific skills is attempted.

Maintenance, Supply and Logistic Duties

In recent years the military services are having to assign a larger proportion of men to duties relating to the testing, maintenance, and supply of machines and weapon systems. Cost of maintenance, over the life of a system, may be several times greater than the initial cost of the system. Similarly, the value of spare parts carried in inventory may exceed the original cost of the machines which use the spare parts.

Thus an increasing proportion of men in service find themselves involved in the logistic operations relating to the maintenance of machines and electronic systems.

Communication and Data-Processing Duties

It is generally thought that future military tactics will require much greater dispersion and mobility of tactical units and weapons. Troops will move quickly from one area to another and the different units of a command may be widely scattered over a large geographic area. These changes in tactics will undoubtedly place much greater importance on communication activities of all kinds.

Closely related to these tactical changes is the increasing demand for the rapid processing of large amounts of data gathered by reconnaissance systems and of data regarding the activities of friendly troops. Thus to the communication problem is added the data processing problem. Small groups of men at isolated command posts, at missile sites, in submarines or

in aircraft, or in small pockets in a fluid battlefield may have to communicate with many other units and keep track of large amounts of information.

Command and Decision-Making Activities

As a further outgrowth of the changes in weapons and tactics described above, it is likely that the future will see the transfer of greater responsibility for important decision-making functions to smaller units and to lower echelons of command. In many cases there will not be sufficient time for the relaying of command decisions, or for the relaying of the information upon which command decisions are based. These decisions will have to be made within the smaller autonomous units where the information is available. By "smaller autonomous units" I refer again to aircraft crews, the crews manning remote radar stations, or crews of remote missile sites. This placing of greater decision-making responsibility at lower echelons may not be desirable for other reasons; however, it is one of the trends of great importance for military skills.

Changing Skill Requirements

Three changes in skill requirements have been selected for emphasis in this paper. These cover changes in (a) information-processing skills, (b) skills involved in monitoring and communicating with machines, and (c) skills involved in management and command decision-making.

Information-Processing Skills

Under this topic will be considered human activities which psychologists usually refer to as perceptual and motor skills. I use a slightly different term, "information-processing", for purposes of emphasis. One of the most widely recognised changes in military skills has been a decrease in emphasis on motor skill, per se, and an increase in the emphasis on a variety of perceptual skills, especially those involving rapid processing of large amounts of information.

On the one hand, tasks such as control of aircraft are decreasing in importance as new systems such as missiles come into use. On the other hand, many of the perceptual tasks required of soldiers in previous years, such as interpreting radar and sonar returns, and reading maps, continue to be important. And new perceptual tasks are added, such as those required to test, monitor, and control new-type machines.

Consequently there is continuing need for research on perceptual problems. Interest in this topic in the United States is shown by two symposia sponsored in recent years by the National Research Council. One of these symposia was devoted to problems of "Pattern Recognition" and the other to problems of "Visual Search Techniques" (conference reports are available from the National Research Council, Washington, D.C.).

Psychological problems relating to the discovery of new ways of displaying information to man's eyes, ears and other senses is a closely related topic (in the area of engineering psychology).

New problems are being encountered here, and new tasks, which will require new perceptual skills, are being created at an increasing rate.

One of the newest, and in the present author's view, possibly the most promising theoretical approaches to the study of perceptual skills is by way of information theory. A typical question is that of man's ability to process and relate information as a function of the way in which the information (input and output signals, stimuli and responses) is encoded. (See the present author's work on stimulus-response compatibility effects.) Other papers to be given at this conference will deal with human information handling so I shall not discuss it further.

Skills Required to Monitor and Direct Machines

Despite the technological progress in designing complex machines, men are still required to monitor or test machine systems, and to correct malfunctions. However in order to perform such tasks men must develop special procedures and acquire the skills needed in testing, monitoring and fault location. Many of the skills required in previous years, such as in repairing electronic equipment, are still important. In addition, soldiers may now be required to program and repair computers, to test automatic guidance systems, and to work intimately with other complex systems.

Thus, in historical perspective, the evolution of military weapons has progressed through successive stages in which the soldier (a) relied chiefly on hand-held or manually aimed and

operated weapons (rifles, hand grenades, artillery), then (b) operated tanks, aircraft, torpedo boats, and other self-propelled weapons, until now (c) he instructs automata, such as missiles and automatic data-processing systems. The skill levels required to instruct and maintain these newest systems are not less than those required in using hand-held weapons. But they often place greater emphasis on perceptual and intellectual skills, or on the rate of information input, and less emphasis on co-ordination or rate of information output.

Decision-Making, Command, and Management Skills

As the complexity of military organizations increases, as mobility and dispersion increases, as firepower increases, as the concept of total war involving the civilian economy as well as military forces is accepted, and as the pace of technological change increases, many profound changes occur in the decision-making skills required at all echelons of the military organization.

The individual soldier, or the small group of men manning a remote weapon or radar site, will be required to make important decisions without time to wait for detailed instructions. In many respects they will be in a position similar to that of the scout or the cavalry patrol of a hundred years ago.

The military officer is increasingly becoming a manager of technological change. As such, he needs to know a great deal about topics far removed from operational doctrine. He needs to understand modern technology, production, and electronics. He also needs a great many human-relation skills in order to handle

the human aspects of technological change. Military officers find themselves increasingly involved in relations with civilians, as many former civilian-military distinctions become less clear.

In the United States the importance of decision-making skills has been recognized in several areas of psychological research. There is much work in the formal aspects of decision-making in both static and dynamic tasks. Work is also under way on the skills required to manage technological change, and on problems of the information required or used for command decision, and on how such information can best be displayed (in control rooms, etc.).

Technology and Simulation

Any discussion of the implications of technological change for research in military psychology would not be complete without reference to the technology of military system simulation for research and test purposes.

War gaming is one form of simulation. It is at least as old as the game of chess, and as athletic contests involving track and field events. Many of the topics discussed in this paper require for their study the simulation of systems and of operational problems, a modern form of war gaming.

Fortunately, for these research purposes, the science of system simulation has also been growing. A few examples of recent research in the United States using advanced simulation techniques may be of interest.

Best known of the more complex system simulators are those used to represent new type aircraft and other vehicles. These simulators have been used successfully for many years in training, but are becoming even more widely used with the advent of jet aircraft and manned space vehicles. Similar devices are also being used increasingly to study human-factor problems in the design of advanced vehicles, such as instrumentation, control, and stability problems.

An important recent development in dynamic system simulation is the adaptation of one of the United States Navy human centrifuges so that the G-forces which a man experiences in the simulator are determined by his own responses in controlling a simulated vehicle.

Another illustration is a simulator which was used by the present author and several former colleagues (at Ohio State University) in studies of human engineering problems of air traffic control.

Complex simulators are now being used to study command and staff functions and to train officers in command functions. One such simulator, developed at the United States Naval Electronics Laboratory, is now in use at the Naval War College.

Another advanced application of system simulation techniques is incorporated in the System Training Program (developed by the System Development Corporation of Santa Monica, California). This training program is used throughout North America in training the crews which man the air defense systems and the military staffs that command the air defenses.

Simulation offers the best means through which the military psychologist can keep ahead of technological change, study problems in advance of their appearance in the field, and thus exert greater influence in shaping the military systems of the future.

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[redacted]

This is a final response to your Freedom of Information Act (FOIA) letter of June 28, 1999, to the Defense Technical Information Center, requesting the following booklets under the provisions of the FOIA:

- Analysis of Atomic Weapon's Effects Upon Army Ground Operations Equipment
- Defense of the North American Continent AD B234 130
- Military Skills in a Changing Technology AD-B234 128

As indicated in our initial response to you dated September 1, 1999, the first document ("Analysis of Atomic Weapon's Effects...") was referred to the Department of the Army for action and a direct reply to you. The remaining two documents, which were reviewed by the Department of Defense, are released in full and are enclosed.

There are no assessable fees for this response in this instance.

2-22-2000 Sincerely,

Per telecon w/Ms. Patricia Skinner, DOD Freedom of Info+Scty Review Office, AD-B234 130+ AD-B234128 are approved for Public Release. A E Ihram

SIGNED

H. J. McIntyre
Director

Completed 2-22-2000

Enclosures:
As stated

cc:
Defense Technical Information Center
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